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1992-93 School Year

# Biology 30, Chemistry 30, Physics 30

## Diploma Examinations Program

# Bulletin

Alberta
EDUCATION

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## SCIENCES DIPLOMA EXAMINATIONS UPDATE FOR 1993

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# SCIENCES DIPLOMA EXAMINATIONS UPDATE FOR 1993

The following information has been updated for teachers and students of Biology 30, Chemistry 30, and Physics 30:

- 1993 Grade 12 Diploma Examinations Schedule
- 1993 Marking Information
- 1992–93 Field Testing and Item Writing

## *1993 Grade 12 Diploma Examinations Schedule*

The 1993 sciences diploma examinations will be administered as follows:

| | | |
|---|---|---|
| Wednesday, Jan. 27 | Chemistry 30 | 9 to 11:30 a.m. |
| | Physics 30 | 1 to 3:30 p.m. |
| Thursday, Jan. 28 | Biology 30 | 9 to 11:30 a.m. |
| Thursday, June 24 | Chemistry 30 | 9 to 11:30 a.m. |
| Friday, June 25 | Physics 30 | 9 to 11:30 a.m. |
| | Biology 30 | 1 to 3:30 p.m. |
| Tuesday, Aug. 17 | Biology 30 | 1 to 3:30 p.m. |
| Wednesday, Aug. 18 | Chemistry 30 | 1 to 3:30 p.m. |
| Thursday, Aug. 19 | Physics 30 | 9 to 11:30 a.m. |

## *1993 Marking Information*

The written-response portion of the sciences diploma examinations is marked by classroom teachers. To qualify as markers, teachers must

- be recommended by their superintendents,
- have taught the subject for two or more years,
- be currently teaching the subject, and
- have an Alberta Permanent Professional Certificate.

We particularly need teachers who can mark examinations written in French.

Teachers who wish to be recommended as markers for the January 1993 examinations should contact their superintendents before September 30, 1992. Teachers who wish to be recommended as markers for the June and August 1993 examinations should contact their superintendents before March 1, 1993.

Marking of the 1993 examinations will take place on the following dates:

| *Biology 30 • Chemistry 30 • Physics 30* | |
|---|---|
| January Administration | February 3 to 6 |
| June Administration | July 6 to 10 |
| August Administration | August 20 to 21 |

## *1992–93 Field Testing and Item Writing*

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Teachers who are interested in these activities should let their superintendents know early in the school term.

# GENERAL INFORMATION

## *Format of the Sciences Examinations*

The time allotted to write the diploma examinations is two and one-half hours. All three sciences examinations have both machine-scorable questions and written-response questions.

The machine-scorable questions are multiple-choice and, for Chemistry 30 and Physics 30, numerical-response. Please refer to the chemistry and physics sections of this bulletin for further details about numerical-response questions.

A separate data booklet is provided for the Chemistry 30 and Physics 30 examinations. All examinations in the three sciences have tear-out pages for rough work.

NOTE: The diploma examinations in the sciences may contain questions that require students to synthesize concepts from more than one unit of study.

## *Use of Scientific Calculators on Examinations*

The term *scientific calculator* includes all hand-held devices designed for mathematical computation. These scientific calculators may have graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students.

Please refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing their examinations.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see Appendix B of this bulletin), one of which states that notes stored in electronic devices may not be brought into the examination room.

## *Assessment of Written Communication Skills*

The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific. Examples of questions, answers, and scoring guides are given in the subject-specific sections of this bulletin.

## *Assessment Standards*

Standards in education are statements that communicate the level of performance necessary to attain a specific goal or objective. Statements of standards assist educators in determining the extent to which students must know the content and demonstrate the required skills to pass the course.

Assessment standards are discussed at the beginning of each specific science section of this bulletin. These standards are applicable to students who attain the *acceptable* standard (a final mark of 50% or higher) and to students who attain the standard of *excellence* (a final mark of 80% or higher).

## *Examiners' Reports*

Following the administration of the January and June examinations, examiners' reports are released. These reports briefly outline the statistical data obtained from the examination administration and provide a diagnostic overview of student performance. Examiners' reports are designed for teacher use. If we can make these reports more useful to you, please let us know. You can reach our examination managers at 427-2948 or by writing to us in care of

Assistant Director
Mathematics/Sciences
Student Evaluation Branch
Alberta Education
Box 43, 11160 Jasper Avenue
EDMONTON, Alberta
T5K 0L2 FAX: 422-4200

## *Annual Report*

An annual report that summarizes results from the January, June, and August diploma examination administrations is released in the fall of each year. The purpose of this report is to inform educators and the public about student achievement in relation to provincial standards.

# SUBJECT-SPECIFIC INFORMATION

# BIOLOGY 30

## Assessment Standards

Students of Biology 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of biological concepts by their increased ability to apply these concepts to relevant situations and to communicate in the specialized language of biology.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, and in particular by the successful completion of Biology 10 and Biology 20.

Students who attain an *acceptable* standard of performance in Biology 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific investigation by designing and interpreting simple laboratory tests. They can readily interpret data that are presented in simple graphs and tables, and can translate symbolic representations of biological functions into word descriptions. They can readily recognize and provide definitions for key biological terms. These students can demonstrate an acceptable level of understanding of biological concepts by tracing the pathways that materials follow as they are transported through human organ systems, by sequentially ordering the major steps of a physiological process, and by formulating simple structural and functional comparisons among components of human organ systems. They can relate human physiological concepts to common everyday experiences, but they may have difficulty relating these concepts to health problems. These students can compose clear and logical descriptive or explanatory statements about major human physiological concepts.

Students who attain a standard of *excellence* in Biology 30 receive a final mark of 80% or higher. In addition to meeting the expectations for an acceptable standard of performance, these students demonstrate their ability and interest in biology and feel confident about their abilities. They can readily interpret interrelated sets of data such as complex graphs and tables. When presenting scientific data, they select the most appropriate form. These students can analyze and evaluate experimental designs. They can easily identify significant parts of human organs and can describe their functions clearly and accurately. They can analyze human physiological problems that involve several interrelated steps, and they can form inferences from extracurricular data that are provided with the problems. These problems would most likely involve regulatory feedback loops and/or a minimum of two interacting human organ systems. Exceptional students can communicate clearly and concisely, using appropriate scientific vocabulary, and can write multiparagraph compositions.

## Structure of the 1993 Examinations

Each Biology 30 Diploma Examination is designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination is limited to those objectives that can be measured by a paper and pencil test.

### Content

The 1993 Biology 30 diploma examinations have the following approximate emphases on core concepts:

| *Concept*[1] | *Per Cent Emphasis* |
|---|---|
| • Cellular Processes | 9 |
| • Homeostatic Mechanisms | 4 |
| • Nutrition and Digestion | 16 |
| • Body Fluids | 15 |
| • Breathing, Gas Exchange, and Transport | 7 |
| • Energy Release | 5 |
| • The Kidney | 10 |
| • Regulation of the Internal Environment | 20 |
| • Voluntary Movement and Body Support | 4 |
| • Human Reproduction | 10 |

## Design

The design of the 1993 Biology 30 diploma examinations is as follows:

| *Question Format* | *Number of Questions* | *Per Cent Emphasis* |
|---|---|---|
| Multiple Choice | 70 | 70 |
| Written Response | 4 | 30 |

## Examination Specifications

The three cognitive levels[2] of Knowledge, Comprehension and Application, and Higher Mental Activities are addressed throughout the examination. Each cognitive level has the following emphasis:

| *Multiple Choice* | *Per Cent Emphasis* |
|---|---|
| Knowledge | 25 |
| Comprehension and Application | 35 |
| Higher Mental Activities | 10 |
| *Written Response* | |
| Comprehension and Application, Higher Mental Activities | 30 |

Process skills are addressed throughout the examination, and in particular by one 10-mark question in the written-response section.

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the cognitive levels and vice versa. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics or cognitive levels.

## *Emphases in the 1993 Examinations*

- Some questions will include contextual material that goes beyond the common scope of the core concepts as defined in the curriculum guide. The inclusion of these questions is not only appropriate but also necessary if higher cognitive skills (application, analysis, evaluation) are to be measured.

- Committees of teachers are encouraged to develop questions that address the broadest possible range of course objectives measurable by a paper and pencil test. This includes emphasizing an understanding of human physiology rather than rote memorization of human anatomy; integrating the main core concepts rather than treating each in isolation; relating the human organism to other life forms rather than treating it in isolation; and incorporating technological concepts, the nature of science, science and society issues, and historical perspectives if appropriate.

- The 30 marks allotted to the written-response section of the 1993 examinations will be distributed among four questions. One of the four questions will present a synopsis of a research project, including pertinent data in the form of graphs and/or tables. The several parts of this question will require students to demonstrate a variety of process skills. This composite question will have a total mark value of 10.

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[1] Concept descriptions have been shortened in this table.
[2] An explanation of cognitive levels is given in Appendix C.

Another written-response question will also be worth 10 marks. This question will present a clearly defined problem to which there are a number of different solutions. The problem will be centred on biological concepts but will include one other component (technology, societal implications, or the nature of science). Students should be able to respond to this second component of the question by drawing on their general knowledge and science problem-solving experiences. This question will also provide an opportunity to measure students' written communication skills. Descriptive scales will be used to measure the three components of the students' responses. Five marks will be allocated for biology concepts, three marks for the second component—i.e., related technologies—and two marks for written communication skills. An example of this type of question, together with sample answers and scoring guides, begins on page 8.

The remaining two questions in the written-response section will range in value from four to six marks. These questions will be clearly defined contextual problems that have specific solutions based on the core concepts of the course. Student responses for each of these questions will be measured by using an analytical scoring guide.

## *Changes to the Examinations for 1994*

The per cent emphasis of machine-scored and written-response questions will continue to be 70% and 30%, respectively. However, the machine-scored section will contain 60 multiple-choice questions worth 60 marks and 15 to 20 diagram-matrix matching questions worth 10 marks. The written-response section will contain four questions similar to those presented in the 1993 examinations.

Field testing of diagram-matrix matching questions began in June 1992. Samples of this question format will be provided in the 1993-94 Sciences Bulletin.

## *Clarification of Word Usage in Examinations*

In past examinations, a number of terms used in the context of scientific process skill questions have confused some students. A sample of such terms with their preferred definitions follows.

| | |
|---|---|
| Hypothesis: | A single proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. |
| Conclusion: | A proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence. |
| Experiment: | A set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations. |
| Variable: | A condition that can change in an experiment.<br>Variables in experiments are categorized as:<br>• **manipulated variables** (independent variables)—conditions that were deliberately changed by the experimenter<br>• **fixed or restrained variables** (controlled variables)—conditions that could have changed but did not, because of the intervention of the experimenter<br>• **responding variables** (dependent variables)—conditions that changed in response to the change of the manipulated variables. |

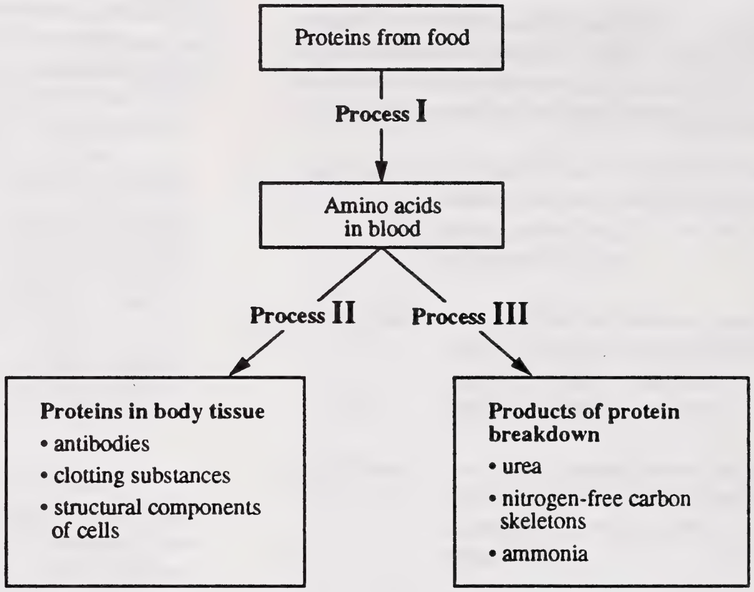
For additional clarification of the specialized terms used to describe science process skills, see Al Gibbs, Anton E. Lawson, *The Nature of Scientific Thinking As Reflected by the Work of Biologists & by Biology Textbooks*, The American Biology Teacher, March 1992, Volume 54, Number 3, page 137.

**Technology**: The development of our understanding of human physiology is directly related to the development of technology. The meaning of technology has many facets, but in general, technology refers to a way of doing something. This includes the development of tools and new techniques for solving problems. It also includes ideas and their organization for achieving practical purposes. In the context of an examination question, technology will include both of these facets of meaning. That is, a technological explanation should include not only identification and descriptions of equipment (tools, products) but also explanations of procedures.

## *Sample Written-Response Question: Open-ended Integrative Question*

*Use the following information to answer question 47.*

**Possible Metabolic Pathways of Ingested Protein**



(10 marks) 47. Select **either** topic A **or** B.

**Topic A**: Identify and explain processes I and II that convert protein in food to amino acids found in the blood, and then further convert those amino acids to protein found in body tissues. Also explain how our knowledge of these processes has been supported by laboratory procedures used by you and/or other scientific investigators.

**Topic B**: Identify and explain processes I and III that convert protein in food to amino acids found in the blood, and then further convert those amino acids to products of protein breakdown. Also explain how our knowledge of these processes has been supported by laboratory procedures used by you and/or other scientific investigators.

Note:

- 5 marks will be awarded for explanations of biological concepts. You must explain at least **two** concepts for **each** process.
- 3 marks will be awarded for explanations of laboratory/investigative procedures. You must explain at least **two** procedures.
- 2 marks will be awarded for written communication skills. Your work must be presented in complete sentences and well-organized paragraphs.
- You are advised to prepare a rough draft of your work on the tear-out pages provided. No marks will be awarded for your rough work.

## *Sample Answers to the Sample Written-Response Question*

This question is open-ended. Therefore, students may describe a great variety of concepts. The concepts given below are suggested answers but the list is not exhaustive. The marker must consider other reasonable descriptions.

**Biological Concepts**

Process I: The student's response must indicate that process I includes protein digestion and absorption of digestive products. A minimum of two of the following concepts constitutes a complete response for process I:

- Chewing and peristalsis expose protein to digestive enzymes.
- Large protein molecules in food are digested to produce amino acids.
- Digestion of protein occurs in the stomach.
- Protein digestion in the stomach requires pepsin, HCl, and an appropriate temperature.
- Protein digestion in the stomach produces polypeptides.
- Protein digestion is completed in the small intestine (duodenum).
- Protein digestion in the small intestine requires a pH of 8, an appropriate temperature, and proteases from the pancreas.
- Enzymes from the duodenum assist in protein digestion.
- In the small intestine, polypeptides are digested to produce amino acids.
- Digestion is a hydrolytic process.
- Amino acids in the digestive tract are absorbed by intestinal villi through diffusion or active transport.
- Amino acids are absorbed by capillaries.
- Hormones such as gastrin and secretin control the release of protein-digesting enzymes.

*After a discussion of process I, the response should make a smooth transition to either process II or process III. For example: amino acids absorbed by capillaries are delivered to body cells where they are synthesized to form human proteins.*

Process II: If topic A is selected, the student must identify process II as protein synthesis. A minimum of two of the following concepts constitutes a complete response for process II:

- Amino acids enter cells by diffusion or active transport.
- Protein synthesis occurs on ribosomes in cells.
- Protein synthesis is controlled by DNA in the nuclei of cells.
- RNA is involved in protein synthesis.
- Amino acids are linked to form polypeptides or proteins.
- Protein synthesis involves dehydration.
- The sequence of amino acids in a protein molecule determines the structure and function of the protein.
- The shape of a protein molecule determines its function.
- Hormones may influence protein synthesis.
- Many important proteins are made in the liver.

*Continued*

Process III: If topic B is selected, the student must indicate that process III includes deamination and cellular respiration. A minimum of two of the following concepts constitutes a complete response for process III:

- Amino acids may be used as an energy source in cellular respiration.
- Amine groups must be removed from amino acids before nitrogen-free carbon skeletons can be respired.
- Removal of nitrogen from amino acids is called deamination.
- Urea is formed as a result of deamination.
- Amine groups and carbon dioxide react to form urea.
- Urea and ammonia production increases with increased metabolism of amino acids (proteins).
- Deamination occurs in the liver.
- Amino acids enter the liver from the blood by diffusion or active transport.
- Nitrogenous wastes enter the blood and are excreted from the body.

## Science and Technology

*The student's response could include a minimum of two of the following explanations of laboratory/investigative procedures:*

- Experiments that simulate digestion provide clues to the conditions required for digestion.
- The Biuret test can be used to identify the presence of protein.
- The xanthoproteic test can be used to indicate the presence of some proteins.
- Chemical analyses of blood, urine, cellular fluid, ECF, liver tissue, muscle, etc., show some of the steps (intermediates) in protein metabolism.
- Use of radioactive tracers shows the pathways of protein metabolism.
- William Beaumont demonstrated protein digestion using a hole in a trapper's stomach.
- Pavlov's experiment showed nervous control of gastric secretion.
- Spallanzani swallowed a sponge and, when removed, the sponge contained gastric juice that digested protein.
- Chromatography can be used to separate and identify amino acids.

*Note: After identifying the procedure, the student should explain the utility of the procedure.*

*Continued*

## *Scoring Guides for the Sample Written-Response Question*

1. **Biological Concepts Component** (5 marks)

| SCORE | SCORING DESCRIPTION |
|---|---|
| **(5)**<br>**EXCELLENT** | The student consistently identifies the main concepts and demonstrates a clear understanding by presenting comprehensive, relevant, and accurate structure/function relationships. The student consistently provides concepts that directly, logically, and sequentially describe the processes involved in topic A or topic B. |
| **(4)**<br>**PROFICIENT** | The student frequently identifies the main concepts and demonstrates a clear understanding by presenting comprehensive, relevant, and accurate structure/function relationships. The student frequently points out processes involved in topic A or topic B in a perceptive, thorough, and logical manner. |
| **(3)**<br>**SATISFACTORY** | The student identifies some of the main concepts and demonstrates a clear understanding by presenting relevant and accurate structure/function relationships. The student provides descriptions of the processes involved in topic A or topic B, with only minor inconsistencies or omissions. |
| **(2)**<br>**LIMITED** | The student identifies some of the main concepts by presenting structure/function relationships. The response is primarily descriptive and non-sequential, with inaccuracies regarding the processes involved in topic A or topic B. |
| **(1)**<br>**POOR** | The student's response contains major errors or omissions and inaccurate structure/function relationships. The response is descriptive and neglects important processes involved in topic A or topic B. |
| **(0)**<br>**INS** | INSUFFICIENT is a special category. It is not an indicator of quality. It should be assigned to papers that do not contain a discernible attempt to address the issue in the assignment or are too brief to assess using this scoring guide. |

*Continued*

## 2. **Science and Technology* Component** (3 marks)

| SCORE | SCORING DESCRIPTION |
|---|---|
| (3)<br>EXCELLENT | The student clearly explains at least two technologies that would allow an investigator to trace important steps of protein metabolism. |
| (2)<br>SATISFACTORY | The student identifies at least two technologies but provides an explanation for only one of the two technologies that would allow an investigator to trace important steps of protein metabolism. |
| (1)<br>POOR | The student simply identifies but does not explain technologies that would allow an investigator to trace important steps of protein metabolism OR the response explains only one technolgy. |
| (0)<br>UNACCEPTABLE | The student incorrectly identifies technologies OR indicates no understanding of the topic. |

*Refer to the meaning of technology on page 7

## 3. **Written Communication Component** (2 marks)

| SCORE | SCORING DESCRIPTION |
|---|---|
| (2)<br>EXCELLENT | The student explains concepts clearly and logically, and demonstrates consistency of thought. Cause-and-effect relationships are shown. The student uses complete sentences that make effective use of scientific vocabulary. If applicable, the student also uses suitable diagrams/sketches to illustrate written explanations. |
| (1)<br>SATISFACTORY | The student explains concepts in complete sentences that use some appropriate scientific vocabulary. The response is of sufficient length to address the major points of the question. |
| (0)<br>UNACCEPTABLE | The student uses inappropriate vocabulary, grammar, and/or sentence structure. The response requires more than one reading to abstract the sense OR the length of the response is inadequate to address even one of the major points of the question. |

## *Samples of Typical Student Responses*

**Example 1, Topic B**

"Process I represents the digestion of big proteins into smaller and smaller pieces until amino acids are formed. This process starts in the mouth where food is chewed and is completed in the intestines. Enzymes such as pepsin cut the large pieces of protein into little pieces called amino acids. The amino acids are then taken into the blood through the wall of the small intestine. The leftovers are excreted.

The digestion of protein can be carried out in a test tube by adding a small piece of meat to some water in the tube. A few drops of HCl and some pepsin powder should also be added to the tube. The tube should then be put in hot water for about an hour. The piece of meat will disapear.

Process III represents using the amino acids to make urine. The kidneys take the leftover amino acids from the blood and put them in the waste called urine. In this way the extra amino acids are removed from the body and cannot act as a poison. The nitrogen-free carbon skeletons are used to build new structures in the body like cell walls and bone. Ammonia is carried out of the body in sweat causing the person to have a bad odor.

A sample of urine can be checked for urea by adding a blue chemical called benedicts and heating it. Urea will make the solution turn red. This will show that the amino acids in the blood passed into the urine."

| Assessment Category | Score |
|---|---|
| Concepts | 3 |
| Technology | 1 |
| Communication | 1 |
| **Total** | 5 |

**Example 2, Topic A**

"Proteins from foods are small enough to go into the blood. Their, the proteins are broken down by enzymes into amino acids and glycerine. The amino acids assembled in the necleolus by RNA. The completed protein can pass back into the bloodstream where they work as enzymes in the digestive system and in lysosomes. The biurette test used to test whether proteins are present or not."

| | |
|---|---|
| Concepts | 1 |
| Technology | 1 |
| Communication | 0 |
| **Total** | 2 |

**Example 3, Topic B**

"Process I is digestion. Food contains proteins that are digested in the stomach. In the stomach, HCl and enzymes breakdown the food into amino acids. The protein is also digested in the small intestine by other enzymes from the pancreas. The amino acids are then absorbed into the blood and moved around the body.

When the amino acids reach the liver then process III begins. Process three is where the amino acids are further broken down to give urea. The urea is moved by the blood to the kidneys where it is removed by the urine. Some of the amino acids may be burned in the body as fuels.

Some procedures used to show these processes are lab experiments on digestion where different foods and enzymes are put into test tubes. The conditions of the tubes shows what is needed for digestion. Also, some scientists have done alot of expirements like the man who had the stomach wound and the doctor who put things in the hole into his stomach to see what would happen."

| | |
|---|---|
| Concepts | 3 |
| Technology | 2 |
| Communication | 1 |
| **Total** | 6 |

**Example 4, Topic A**

"Well, process I is when the food is taken in. The mouth breaks up food and it is swallowed into the stomach where food is broken up. The acid and the juices make the food able to go to the blood. The blood can make use of the food in various organs of the body. The body makes it up into other things needed such as vitamins and fuels. The remains of food are removed by the rest of the system.

Process II is producing substances for the blood. The blood is important because it transports gases and food around the body. The blood with white blood cells and antibodies also helps to protect the body from disease. The heart and blood vessels make the blood circulate around. The blood will also move wastes from proteins.

Many scientists have been able to identify the steps of proteins. First there was digestion and then using proteins was discovered. Lab investigations help us to decide how proteins work and what there made up of. The labs are used to decide how the body works on proteins."

| **Assessment Category** | **Score** |
|---|---|
| Concepts | 0 |
| Technology | 0 |
| Communication | 0 |
| **Total** | 0 |

**Example 5, Topic B**

"Process I symbolizes digestion of proteins to form amino acids. In the stomach, gastric juice made up of HCl and pepsin breaks down proteins into smaller chains of amino acids (polypeptides). In the duodenum, the acid chyme becomes neutralized by secretions from the pancreas. Enzymes in the pancreas reduce polypeptides to amino acids. Then the amino acids enter the blood by osmosis and active transport where they are carried to the liver for further processing.

Process III represents deamination of surplus amino acids to form urea which is transported to the kidneys to be eliminated from the body. Part of the amino acid can be converted to glucose.

A useful method to determine the different kinds of amino acids found in the duodenum would be to use paper chromatography. Another use of technology would be to feed parameciums a red dye and watch the dye in the vaculoles change to a blue color as acid enters the vacuole."

| **Assessment Category** | **Score** |
|---|---|
| Concepts | 4 |
| Technology | 2 |
| Communication | 2 |
| **Total** | 8 |

# CHEMISTRY 30

## *Assessment Standards*

Students who attain an *acceptable* standard of performance and do not attain the standard of excellence in Chemistry 30 have gained new knowledge and abilities in chemistry but can anticipate difficulties if they choose to enrol in postsecondary chemistry courses. Such students can state and solve numerous problems that require only a one-step solution. For example, they can derive a pH value from a given hydronium ion concentration or find the net voltage for a redox reaction by using the data booklet. These same students would experience difficulty with multiple-step problems such as finding the pH of a partially neutralized mixture of an acid and a base. They are also unlikely to correctly answer questions involving concepts from more than one unit. They are capable of balancing an equation (combustion, formation, neutralization, or redox) and of solving the standard stoichiometric problems based upon these equations. Following the directions in laboratory procedures does not present a problem for these students, nor does drawing a graph from experimental data or reading values from the graph.

Students who attain a standard of *excellence* in Chemistry 30 should be well enough prepared to undertake successfully the next level of chemistry, whether it be at a university, a technical school, or a nursing school. These students can create their own laboratory procedures when given a clear definition of a problem. They can recognize weaknesses in laboratory work and can find ways to correct the weaknesses. These students can write their own equations for formation, combustion, neutralization, and redox reactions, and can solve many variations of stoichiometric problems based upon these equations. They are able to transfer what they see happening in a test tube into equation form and are able to express scientific ideas clearly. They can extract valid inferences from graphical data. They can usually cope with problems that involve overlapping of two or more concepts. The most significant characteristic of this group is that they can solve problems of a new and novel nature and can extrapolate these solutions to higher levels of understanding. These students usually possess good communication skills and can extract vital information from laboratory data or from word problems.

## *Structure of the 1993 Examination*

Each Chemistry 30 Diploma Examination is designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination is limited to those objectives that can be measured by a paper and pencil test.

### Content

The 1993 Chemistry 30 diploma examinations have the following approximate emphases on core concepts:

| *Concept*[1] | *Per Cent Emphasis* |
|---|---|
| • Chemical Energetics | 32 |
| • Acids and Bases | 34 |
| • Oxidation-Reduction | 34 |

### Design

The design of the 1993 Chemistry 30 diploma examinations is as follows:

| *Question Format* | *Number of Questions* | *Per Cent Emphasis* |
|---|---|---|
| Multiple Choice | 42 | 60 |
| Numerical Response | 7 | 10 |
| Written Response | 3 | 30 |

### Examination Specifications

The three cognitive levels[2] of Knowledge, Comprehension and Application, and Higher Mental Activities are addressed throughout the examination. Each cognitive level has the following emphasis:

---

[1] Concept descriptions have been shortened in this table.
[2] An explanation of cognitive levels is given in Appendix C.

| ***Multiple Choice*** | ***Per Cent Emphasis*** |
|---|---|
| Knowledge | 30 |
| Comprehension and Application | 30 |
| Higher Mental Activities | 10 |
| ***Written Response*** | |
| Comprehension and Application, Higher Mental Activities | 30 |

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the cognitive levels and vice versa. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics or cognitive levels.

## *Emphases in the 1993 Examinations*

- We will continue to evaluate written-response questions on how well the answer is communicated.

- Some questions will include concepts from more than one of the core concepts.

- Written-response questions will continue to include a written component that requires students to see relationships among concepts learned.

- Written-response questions may require students to write balanced chemical reaction equations including correct states of matter.

- Numerical answers are to be rounded only once, at the end of the question. Intermediate numbers are to be used as displayed on the calculator.

- The diploma examination treats the terms oxidation number and oxidation state as synonyms. It has come to our attention that some resource materials are making an artificial and false distinction between these terms.

## *Changes to the Field Tests*

All field tests *may* contain questions from optional units such as equilibrium.

## *Chemistry 30 Data Booklet Update*

Several minor changes and additions will be made to the 1993 data booklet.

- Gas constant will be added to the miscellaneous section.

- Ideal Gas Law will be added to the miscellaneous section.

- Quadratic Equation will be added to the miscellaneous section.

- Elements 104–109 on the Periodic Chart will be changed to reflect the current IUPAC rules.

- In addition to the existing system, the Groups on the Periodic Chart will be numbered from 1 to18.

## *Communications Assessment of Written Responses*

The intent of evaluating communications is to reward students for creating responses that are on topic, clear, concise, and well written. Communications assessment on the chemistry diploma examinations will focus on three main criteria.

First, the response must be on topic; however, it does not have to be 100% correct. For example, a student who selects incorrect oxidizing and reducing agents in a redox question will not lose communication marks, because the error was in content appropriate to the question. If a student responds to a redox question as if it were an acid-base question, no communication marks will be given regardless of how well the response is written, because the answer is off topic. Communication in the context of the chemistry diploma examination is loosely coupled to content, in that the response need not be correct but it must be appropriate.

Secondly, the response must stand alone and require no interpretation. This means that the response is organized in a logical manner and that the marker does not have to read the question to understand the response, nor does the marker have to infer or interpret the response.

Thirdly, the response must respect the conventions of the mode of communication selected. For example, if a student elects to write a net ionic equation, the reactants and the products should have the appropriate states. Similarly, students electing to respond in paragraph form should use complete sentences and correct spelling.

To illustrate these criteria, a new draft scoring guide and five examples are presented on the following pages.

Markers of the 1992 Chemistry 30 diploma examinations made the following comments about communication:

- “Shorthand” should not be used for written responses because there is no guarantee that a specific teacher’s/student’s shorthand notation will be understood by all markers.

- The “box” method of stoichiometry is not an acceptable method of communicating an answer.

## CHEMISTRY COMMUNICATION SKILLS (V10.1)

| LEVEL | CRITERIA |
|---|---|
| **4**<br>**(80% or higher)** | The marker does not have to interpret any part of the response. No reference to the question is needed to understand the response. The response is clear, concise, and presented in a logical manner. All conventions of the mode of communication are followed. |
| **3**<br>**(65% to 79%)** | The marker may have to interpret part of the response or the response is poorly organized, but no reference to the question is needed to understand the response and there are no errors in the conventions of the mode of communication.<br>OR<br>The marker does not have to interpret the response; however, there are errors in the conventions of the mode of communication selected. |
| **2**<br>**(50% to 64%)** | The marker has to interpret the response or the response is so poorly organized that the marker has to refer to the question in order to understand the response. The response may be ambiguous and/or disorganized, and there are errors in the conventions of the mode of communication selected.<br>OR<br>The response is limited in length; however, the completed portion meets the criteria of level 4. |
| **1**<br>**(35% to 49%)** | The response is limited in length, but the marker does not have to interpret the response. However, there are errors in the conventions of the mode of communication selected. |
| **0** | The response is limited in length. The response is ambiguous and/or disorganized and contains errors in the conventions of the mode of communication selected. |
| **NR** | No response is given. |

## *Sample Questions*

*Use the following information to answer question 2.*

- Aluminum is produced by the electrolysis of molten ore. The reaction at the cathode of the electrolytic cell can be simplified and written as

$$Al^{3+}_{(l)} + 3e^- \rightarrow Al_{(l)}$$

- The energy required to produce aluminum by electrolysis is 72 kJ/g.
- Electrolysis is not required when aluminum is recycled. A major energy expenditure in recycling is the energy required to heat the aluminum to its melting point and to melt it.
- The molar heat of fusion of $Al_{(s)}$ is 10.7 kJ/mol.

**2.** **a.** Calculate the amount of energy required to recycle a 16.1 g aluminum pop can. Assume that the aluminum for recycling is at an initial temperature of 20°C.

energy to recycle aluminium $= mc\Delta t$

$= 16.1\,g\,(0.900\,J/g°C)(660-20)°C$

$= 9.3\,kJ$

**Level 4**

The response is clear, concise, and well organized. There is an error in content, but there are no errors in the method of communication selected. As a result, this response meets the criteria of level 4.

**b.** Give an advantage and a disadvantage of recycling aluminum compared with producing it from ore by electrolysis. Should aluminum be recycled? Justify your answer.

Advantage - reduces waste

- less energy is used (9.3 kJ/can for recycling vs ($72\,kJ/g \times 16.1\,g/can$) 1159.2 kJ/can) for production from electrolysis

Disadvantage - collect and sort aluminium containers

∴ Aluminium should be recycled because it requires 124 times less energy (1159.2 kJ/can / 9.3 kJ/can) than producing aluminium from electrolysis

*Use the following information to answer question 3.*

A student was given four solutions labelled W, X, Y, and Z. One contained $Cl^-_{(aq)}$ ions, one contained $Br^-_{(aq)}$ ions, one contained $Sn^{2+}_{(aq)}$ ions, and one contained $Fe^{2+}_{(aq)}$ ions.

In order to identify each solution, the student selected the following acidified reagents:

$MnO_4^-{}_{(aq)}$, $SO_4^{2-}{}_{(aq)}$, $NO_3^-{}_{(aq)}$, and $Cr_2O_7^{2-}{}_{(aq)}$

The student combined some of each solution with the reagents and recorded these results:

| | Unknown Solutions | | | |
|---|---|---|---|---|
| **Reagents** | W | X | Y | Z |
| $MnO_4^-{}_{(aq)}$, $H^+_{(aq)}$ | √ | √ | √ | √ |
| $SO_4^{2-}{}_{(aq)}$, $H^+_{(aq)}$ | × | × | √ | × |
| $NO_3^-{}_{(aq)}$, $H^+_{(aq)}$ | × | √ | √ | × |
| $Cr_2O_7^{2-}{}_{(aq)}$, $H^+_{(aq)}$ | √ | √ | √ | × |

**3.** If "√" indicates a spontaneous reaction and "x" indicates no reaction, identify what each solution contained. Explain how you reached your conclusions.

- Solution C is the strongest reduction agent of the fore since it react wit all the test regents. Of the fore solutions given, $Sn^{2+}$ is the strongest accordingly to the Redox table' (See page 11 of data booklet)
- Solution B is the second strongest of the fore since it reacts with all but one of the test reagents, thus it must be $Fe^{2+}$.

**Level 3**

Despite errors in the conventions of the mode of communication, this response meets the criteria for level 3 because it is clear and concise. As well, the marker does not have to do any interpreting or guessing. The response is complete, on topic, and logical.

*Use the following information to answer question 2.*

- Aluminum is produced by the electrolysis of molten ore. The reaction at the cathode of the electrolytic cell can be simplified and written as

$$Al^{3+}_{(l)} + 3e^- \rightarrow Al_{(l)}$$

- The energy required to produce aluminum by electrolysis is 72 kJ/g.
- Electrolysis is not required when aluminum is recycled. A major energy expenditure in recycling is the energy required to heat the aluminum to its melting point and to melt it.
- The molar heat of fusion of $Al_{(s)}$ is 10.7 kJ/mol.

**2.** **a.** Calculate the amount of energy required to recycle a 16.1 g aluminum pop can. Assume that the aluminum for recycling is at an initial temperature of 20°C.

energy to recycle

$\Delta H = mc\Delta t + nH$

$= (0.0161 g (0.900 J/g°C) 660°C) + (16.1 g / 26.98 g/mol) 10.7 kJ$

$= 15.9 kJ$

**b.** Give an advantage and a disadvantage of recycling aluminum compared with producing it from ore by electrolysis. Should aluminum be recycled? Justify your answer.

**Level 2**

The marker does not have to refer to the question or interpret the response. The response is appropriate to one part of the question. However, because the response to other parts of the question is insufficient, full marks cannot be awarded. Because there are no errors in the mode of communication selected, a level of 2 is assigned.

*Use the following information to answer question 3.*

A student was given four solutions labelled W, X, Y, and Z. One contained $Cl^-_{(aq)}$ ions, one contained $Br^-_{(aq)}$ ions, one contained $Sn^{2+}_{(aq)}$ ions, and one contained $Fe^{2+}_{(aq)}$ ions.

In order to identify each solution, the student selected the following acidified reagents:

$MnO_4{}^-_{(aq)}$, $SO_4{}^{2-}_{(aq)}$, $NO_3{}^-_{(aq)}$, and $Cr_2O_7{}^{2-}_{(aq)}$

The student combined some of each solution with the reagents and recorded these results:

| | Unknown Solutions | | | |
|---|---|---|---|---|
| Reagents | W | X | Y | Z |
| $MnO_4{}^-_{(aq)}$, $H^+_{(aq)}$ | √ | √ | √ | √ |
| $SO_4{}^{2-}_{(aq)}$, $H^+_{(aq)}$ | × | × | √ | × |
| $NO_3{}^-_{(aq)}$, $H^+_{(aq)}$ | × | √ | √ | × |
| $Cr_2O_7{}^{2-}_{(aq)}$, $H^+_{(aq)}$ | √ | √ | √ | × |

3. If “√” indicates a spontaneous reaction and “×” indicates no reaction, identify what each solution contained. Explain how you reached your conclusions.

Solution A contains $Br^-$

Solution B contains $Cl^-(aq)$.

Soln C contains $Sn^{2+}$.

Solution D contain $Fe^{2+}$ ions

**Level 1**

The response is limited in length but the marker does not have to interpret the response. The response is appropriate to a level 2. However, the errors in the conventions of the mode of communication result in this response being assigned a level of 1.

*Use the following information to answer question 3.*

A student was given four solutions labelled W, X, Y, and Z. One contained $Cl^-_{(aq)}$ ions, one contained $Br^-_{(aq)}$ ions, one contained $Sn^{2+}_{(aq)}$ ions, and one contained $Fe^{2+}_{(aq)}$ ions.

In order to identify each solution, the student selected the following acidified reagents:

$MnO_4^-{}_{(aq)}$, $SO_4^{2-}{}_{(aq)}$, $NO_3^-{}_{(aq)}$, and $Cr_2O_7^{2-}{}_{(aq)}$

The student combined some of each solution with the reagents and recorded these results:

| | Unknown Solutions | | | |
|---|---|---|---|---|
| Reagents | W | X | Y | Z |
| $MnO_4^-{}_{(aq)}$, $H^+_{(aq)}$ | √ | √ | √ | √ |
| $SO_4^{2-}{}_{(aq)}$, $H^+_{(aq)}$ | × | × | √ | × |
| $NO_3^-{}_{(aq)}$, $H^+_{(aq)}$ | × | √ | √ | × |
| $Cr_2O_7^{2-}{}_{(aq)}$, $H^+_{(aq)}$ | √ | √ | √ | × |

**3.** If "√" indicates a spontaneous reaction and "×" indicates no reaction, identify what each solution contained. Explain how you reached your conclusions.

First one is $Sn^{2+}$ because it is the strongest, next is $Fe^{2+}$. That leaves $Cl^-$ and $Br^-$, but since $Cl^-$ is better than $Br^-$ its next

**Level 0**

The response is incoherent and provides the marker with very little detail to interpret. As a result, the response is assigned a level of 0 for communication.

# PHYSICS 30

## Assessment Standards

Students who attain an *acceptable* standard of performance and do not attain the standard of excellence in Physics 30 have gained new skills and knowledge in physics but can anticipate severe difficulties if they choose to enrol in postsecondary physics courses. Such students can state and solve problems that can be related quickly to an equation in the data booklet. Their laboratory skills are limited to following explicit directions and to using laboratory data to verify known physics information. These students are capable of defining and calculating quantities such as slope, refractive index, orbit radius, electric force, and photoelectric work function. They tend to use item-specific methods in their problem solving and rarely use the major generalizations of physics such as Newton's Laws or the conservation laws of charge, momentum, and energy. These students rely heavily on the equations provided in the data booklet and often use such equations outside the equations' domain of validity.

Students who attain a standard of *excellence* in Physics 30 have demonstrated their ability and interest in both mathematics and physics and feel confident about their scientific abilities. These students should encounter little difficulty in postsecondary physics programs and should be encouraged to pursue careers in which they will utilize their talents in physics. Minor changes in problem format do not cause these students major difficulties. Students who attain a standard of *excellence* show far more flexibility and creativity than the average. They seek general methods and are not afraid to use conservation laws to solve an unusual problem. They transfer knowledge from one area of physics to another and can express their answers in clear and concise terms. In the laboratory, students who attain a standard of *excellence* can cope with data that are less than perfect or with instructions that are incomplete. They make inferences that are not part of the "known" parts of physics. In terms of concept development, they can make the distinction between vectors and scalars and between forces and fields. This group of students can also apply these distinctions to solve problems.

## Structure of the 1993 Examinations

Each Physics 30 Diploma Examination is designed to reflect the core concepts outlined in the *Program of Studies for Senior High Schools*. The examination is limited to those objectives that can be measured by a paper and pencil test.

### Content

The 1993 Physics 30 diploma examinations have the following approximate emphases on core concepts:

| *Concept*[1] | *Per Cent Emphasis* |
|---|---|
| • Nature and Behavior of Light | 25 |
| • Electric and Magnetic Fields | 25 |
| • Electromagnetic Radiation | 15 |
| • Structure of Matter | 20 |
| • Modern Physical Theories | 15 |

### Design

The design of the 1993 Physics 30 diploma examinations is as follows:

| *Question Format* | *Number of Questions* | *Per Cent Emphasis* |
|---|---|---|
| Multiple Choice | 42 | 60 |
| Numerical Response | 7 | 10 |
| Written Response | 4 | 30 |

### Examination Specifications

The three cognitive levels[2] of Knowledge, Comprehension and Application, and Higher Mental Activities are addressed throughout the examination. Each cognitive level has the following emphasis:

---

[1] Concept descriptions have been shortened in this table.
[2] An explanation of cognitive levels is given in Appendix C.

| ***Multiple Choice*** | ***Per Cent Emphasis*** |
|---|---|
| Knowledge | 25 |
| Comprehension and Application | 35 |
| Higher Mental Activities | 10 |
| ***Written Response*** | |
| Comprehension and Application, Higher Mental Activities | 30 |

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the cognitive levels and vice versa. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics or cognitive levels.

## *Emphases in the 1993 Examinations*

- Some questions will require the synthesis of concepts from more than one of the core concepts.
- All written-response questions involving calculations require students first to state an explicit formula statement from the data booklet and, secondly, to explicitly provide the substituted values.
- Numerical answers are to be rounded only once, at the end of the question. Intermediate numbers are to be used as displayed on the calculator.
- Routine calculations based on the equations in the data booklet will be limited to 30% of the examination.
- The written-response section will contain one open-ended question worth approximately 10% of the examination. This question will integrate various concepts covered in the Physics 30 course and will test students at both the comprehension and understanding cognitive level and the higher mental activities cognitive level.

## *Scoring the Written Response*

All four written-response questions will be evaluated in terms of students' communication skills. Students demonstrating good communication skills show respect for the conventions that are appropriate to the particular response required. In physics, these conventions typically include labelling and scaling axes, writing data booklet equations, substituting values, using appropriate units and significant digits, and organizing the solution. Written responses will also be assessed on the basis of conventions for good writing. A suggested scheme for awarding the communication skills mark follows.

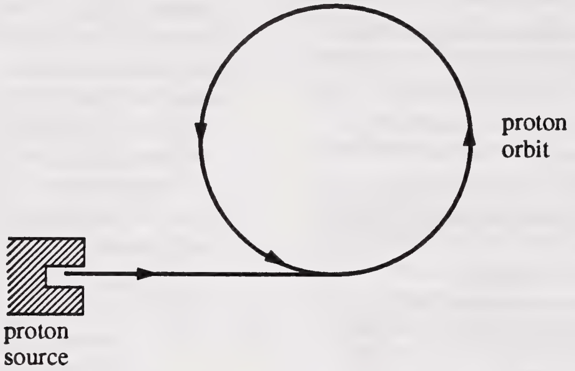
| | |
|---|---|
| Score of 2 | The presentation of ideas or solutions is coherent and well organized. The conventions for problem solving in physics are followed. Complete sentences are used where descriptive answers are required. The writing communicates an understanding of the basic underlying concepts and relationships. |
| Score of 1 | Ideas or solutions are presented but not in a coherent and organized manner. A convention appropriate to the response is missing or not evident. The marker has difficulty following the solution but is able to presume that the student understands underlying concepts and relationships. |
| Score of 0 | The response is very disjointed. Ideas are not presented clearly or are missing. Multiple conventions appropriate to the task are disregarded. Direction is lacking, and any understanding of underlying concepts and relationships is not |

evident in solutions. The material presented does not communicate the intended task.

This marking scheme can be used for questions that involve descriptions and/or calculations. Two examples of questions that can be evaluated using this scheme follow.

**Example 1**

*Use the following information to answer question 1.*



The magnitude of a magnetic field may be calculated by measuring the orbit radius and orbit time of a proton in the field. The velocity of the proton is in the plane of the paper.

**1.** In a particular field, the orbit radius is 0.970 m and the orbit time is $2.80 \times 10^{-7}$ s.

**a.** Determine the speed of the proton in its orbit.

$d = 2\pi R = vt$

$v = 2\pi R/t$

$= 2\pi(0.970 \text{ m})/(2.80 \times 10^{-7} \text{ s})$

$v = 2.18 \times 10^{7}$ m/s

There are **three** checks for this part:

1. using $d = 2\pi R$ and $d = vt$
2. equating $2\pi R$ to $vt$
3. an answer of $v = 2.18 \times 10^{7}$ m/s

**b.** Determine the magnitude of the magnetic field. (If you are unable to calculate the speed in **part a**, use the hypothetical value $v = 2.55 \times 10^{7}$ m/s.)

$$F_m = F_c$$

$$qvB = mv^2/R$$

$$B = \frac{mv}{qR}$$

$$B = \frac{(1.67 \times 10^{-27}\ \text{kg})(2.18 \times 10^{7}\ \text{m/s})}{(1.60 \times 10^{-19}\ \text{C})(0.970\ \text{m})}$$

$$B = 0.235\ \text{T}$$

There are **three** checks for this part:

1. equating $F_m$ to $F_c$
2. using $F_m = qvB$ or $F_c = mv^2/R$
3. an answer of $B = 0.235$ T

**c.** What is the direction of the external magnetic field?

*The direction of the magnetic field is into the paper.*

There are **two** checks for this part:

1. direction of the magnetic field is **perpendicular** to the paper
2. direction of the magnetic field is **into** the paper

Communication skills:

**Two** checks will be awarded on the basis of the definition presented on page 25. Conventions to consider are the writing of data booklet equations, correct substitution, units, significant digits, and solution organization.

Example 1 has a total of 10 checks for 5 marks. The checks are converted to marks using the table on page 28.

| Checks | Marks |
|---|---|
| 10 | 5 |
| 8 or 9 | 4 |
| 6 or 7 | 3 |
| 4 or 5 | 2 |
| 2 or 3 | 1 |
| 0 or 1 | 0 |

**Example 2**

**2.** Microwave ovens have glass (or plastic) windows. These windows are constructed with metallic mesh having holes about 3 mm in diameter. Most microwave ovens operate at a frequency of $2.45 \times 10^9$ Hz.

**a.** Explain the function of the metallic mesh and explain why the mesh must be made of a metal rather than a nonmetallic substance.

*The metallic mesh keeps the microwave radiation within the oven and protects the cook from the harmful microwaves. The metallic mesh also reflects the microwaves back into the oven and allows visible light to pass through. A nonmetallic substance may not reflect the microwaves.*

There is a maximum of **four** checks for this part:

**Function** (maximum of three):

1. confines microwaves to oven
2. safety of the cook (either stated directly or implied by reference to harmful effects)
3. acts as a diffraction grating for microwaves
4. allows light out or allows the cook to see in
5. acts for maximum efficiency in that microwaves are reflected back in

**Choice of Materials** (maximum of two):

1. metallic mesh reflects microwaves
2. nonmetallic materials either absorb microwaves and heat up or allow microwaves to pass through

**b.** Explain, with supporting calculations, why the holes of the mesh are about 3 mm in diameter.

$\lambda = c/f$

$= (3.00 \times 10^8 \text{ m/s})/(2.45 \times 10^9 \text{ Hz})$

$\lambda = 0.122 \text{ m}$

*The holes are much smaller than the wavelength of the microwaves. Therefore, the mesh appears solid to the microwaves and reflects them all back into the oven. The holes are much larger than the wavelength of visible light. Therefore, the mesh is transparent to light and the cook can see into the oven.*

There are **four** checks for this part:

1. calculation of the wavelength of the microwaves
2. an answer of λ = 0.122 m (answers that are rounded to 0.1 m are also acceptable)
3. holes in the mesh need to be much smaller than the wavelength of the microwaves
4. holes in the mesh need to be much bigger than the wavelength of visible light

**c.** Give an alternative design for the window that would serve the same purpose as the glass/mesh combination.

*Use leaded or other high metal content glass.*

OR

*Use tinted glass or glass with a metallic coating.*

OR

*Use 3 mm slits in two different planes.*

There are **two** checks for this part:

1. a plausible design such as polarized glass or tinted glass

2. a design that works (these will be varied and numerous)

Communication skills:

**Two** checks will be awarded on the basis of the definition presented on page 25. Conventions to consider are written communcation skills such as use of complete sentences, grammar, spelling, and organization of response. The use of a calculation to support the discussion should also be considered.

Example 2 has a total of 12 checks for 5 marks. The checks are converted to marks using the table below:

| Checks | Marks |
|---|---|
| 11 or 12 | 5 |
| 9 or 10 | 4 |
| 6, 7, or 8 | 3 |
| 4 or 5 | 2 |
| 2 or 3 | 1 |
| 0 or 1 | 0 |

## *Numerical Response Questions in the 1993 Diploma Examinations*

- The 1992 Physics 30 examinations included a numerical-response section for the first time. These seven machine-scored questions involved routine calculations and were classified as predominantly comprehension and application. Each question specified the number of digits required in the answer.

- Similar instructions for completing the numerical-response section are given in the chemistry, mathematics, and physics examinations. A sample instruction sheet for physics appears on the next page, followed by sample numerical-response questions. Generally, students followed the instructions quite well. However, some students did not always enter the first digit of their answer in the left-hand column as instructed. A number of students did not round their answers but simply truncated the answers from their calculator. A small number of students bubbled their recorded answer incorrectly. Teachers should emphasize that students need to read the instructions carefully before entering answers on the answer sheets and to take great care that their answers are recorded in the appropriate spaces.

# *Part B*

***Instructions***

- Read each question carefully.
- Consider all numbers used in the questions to be the result of a measurement.
- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**
- Use an HB pencil only.
- If you wish to change an answer, erase **all** traces of your first answer.

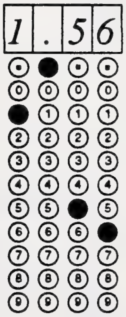
***Sample Questions and Solutions***

If the angle of incidence in air is 47.6° and the angle of refraction is 28.3°, the index of refraction is __________.
(Round and record your answer to three digits.)

$$n = \frac{\sin \theta_1}{\sin \theta_2}$$

$$n = \frac{\sin 47.6^\circ}{\sin 28.3^\circ} = 1.5576328$$

**Record 1.56 on the answer sheet** ⟶



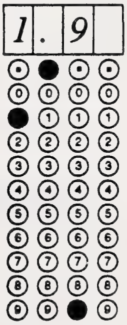
A microwave of wavelength 16 cm has a frequency of $b \times 10^9$ Hz. The value of $b$ is __________.
(Round and record your answer to two digits.)

$$f = c/\lambda$$

$$= (3.00 \times 10^8 \text{ m/s})/(0.16 \text{ m})$$

$$f = 1.875 \times 10^9 \text{ Hz}$$

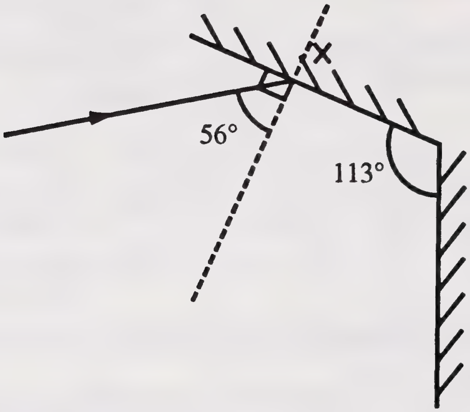
**Record 1.9 on the answer sheet** ⟶



***Start Part B immediately.***

## *Sample Numerical-Response Questions*

*Use the following information to answer question 1.*



A ray of light hits the first mirror at point X and is reflected to the second mirror, where it is reflected again.

**1.** If the angle of incidence is 56° and the angle between the mirrors is 113°, then the angle between the final reflected ray and the second mirror is __________. (Round and record your answer to **two** digits.)

Answer Sheet

| 3 | 3 | | |
|---|---|---|---|
| ⊙ | ⊙ | ⊙ | ⊙ |
| ⓪ | ⓪ | ⓪ | ⓪ |
| ① | ① | ① | ① |
| ② | ② | ② | ② |
| ● | ● | ③ | ③ |
| ④ | ④ | ④ | ④ |
| ⑤ | ⑤ | ⑤ | ⑤ |
| ⑥ | ⑥ | ⑥ | ⑥ |
| ⑦ | ⑦ | ⑦ | ⑦ |
| ⑧ | ⑧ | ⑧ | ⑧ |
| ⑨ | ⑨ | ⑨ | ⑨ |

Angle of reflection at first mirror = 56°

Angle between first reflected ray and first mirror = 90° – 56° = 34°

Angle between second reflected ray and second mirror = 180° – 113° – 34° = 33°

Answer: 33°

Recorded answer: 33

**RECORD THE ANSWER ON THE ANSWER SHEET**

**2.** If a proton is accelerated from rest through a potential difference of $1.10 \times 10^{6}$ V, it attains a final speed, expressed in scientific notation, of $\boldsymbol{b} \times 10^{w}$ m/s. The value of ***b*** is __________.
(Round and record your answer to **three** digits.)

Answer Sheet

| 1 | . | 4 | 5 |
|---|---|---|---|
| ⊙ | ● | ⊙ | ⊙ |
| ⓪ | ⓪ | ⓪ | ⓪ |
| ● | ① | ① | ① |
| ② | ② | ② | ② |
| ③ | ③ | ③ | ③ |
| ④ | ④ | ● | ④ |
| ⑤ | ⑤ | ⑤ | ● |
| ⑥ | ⑥ | ⑥ | ⑥ |
| ⑦ | ⑦ | ⑦ | ⑦ |
| ⑧ | ⑧ | ⑧ | ⑧ |
| ⑨ | ⑨ | ⑨ | ⑨ |

$$v = \sqrt{\frac{2qV}{m}}$$

$$= \sqrt{\frac{2(1.6 \times 10^{-19}\ \text{C})(1.10 \times 10^{6}\ \text{m/s})}{(1.67 \times 10^{-27}\ \text{kg})}}$$

Answer: $1.451821\ldots \times 10^{7}$ m/s

Recorded answer: 1.45

**RECORD THE ANSWER ON THE ANSWER SHEET**

**3.** The momentum of a photon with $5.1 \times 10^{-19}$ J of energy, expressed in scientific notation, is $b \times 10^{-\boldsymbol{w}}$ kg•m/s. The value of the exponent ***w*** is __________.

Answer Sheet

| 2 | 7 |  |  |
|---|---|---|---|
| ⊙ | ⊙ | ⊙ | ⊙ |
| ⓪ | ⓪ | ⓪ | ⓪ |
| ① | ① | ① | ① |
| ● | ② | ② | ② |
| ③ | ③ | ③ | ③ |
| ④ | ④ | ④ | ④ |
| ⑤ | ⑤ | ⑤ | ⑤ |
| ⑥ | ⑥ | ⑥ | ⑥ |
| ⑦ | ● | ⑦ | ⑦ |
| ⑧ | ⑧ | ⑧ | ⑧ |
| ⑨ | ⑨ | ⑨ | ⑨ |

$E = pc$ for a photon

$$p = \frac{E}{c}$$

$$= \frac{5.1 \times 10^{-19}\ \text{J}}{3.00 \times 10^{8}\ \text{m/s}}$$

Answer: $1.7 \times 10^{-27}$ kg•m/s

Recorded answer: 27

**RECORD THE ANSWER ON THE ANSWER SHEET**

## *Comments About Graphing and Suitable Averaging Procedures*

Students have become quite proficient at constructing graphs for experimental data. However, when asked to analyze a graph, students have some difficulty in finding the slope and considerable difficulty in using the slope or another suitable averaging procedure to further analyze the data.

### Finding Slope

Generally, students understand that slope is defined as the rise/run, but it may be useful to review some general guidelines for finding slope.

1. Always use on-line points that can be read easily.
2. The triangle should always be large so as to minimize calculation errors.
3. Data points should not be used in a slope calculation.
4. The origin should not be used as a suitable point.
5. Units and powers of ten should be included in the calculation.
6. Significant digits for the slope are determined by the significant digits of the rise and of the run, not the digits expressed in the axis labels.

### Averaging Procedures

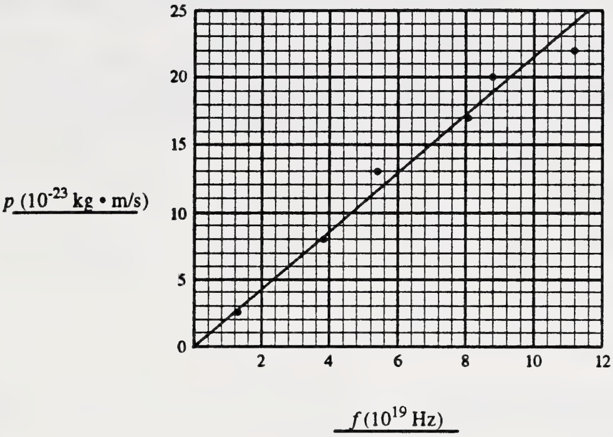
Students should be made aware that finding slope is the most suitable averaging procedure we have. Therefore, when they are asked to use an averaging procedure to analyze data, slope should be their first choice. If they do not use slope, then they should use the average of the desired values or the weighted mean should be used (not the average of the manipulated and responding variables). Care must be taken when using this method because the origin or another non-permissible value may be given as data. An example illustrating both a slope calculation and another suitable averaging precedure, and their use, follows.

*Example*

Independent measurements were made of the momentum $p$ and of the frequency $f$ of X-rays.
The results are summarized in the table:

| $p$ ($10^{-23}$ kg•m/s) | $f$ ($10^{19}$ Hz) |
|---|---|
| 2.5 | 1.3 |
| 8.0 | 3.9 |
| 13.0 | 5.4 |
| 17.0 | 8.1 |
| 20.0 | 8.8 |
| 22.0 | 11.2 |

**a.** From the data in the table, plot a graph of momentum as a function of frequency, placing frequency on the horizontal axis.



**b.** Use the slope of the graph or some other suitable averaging procedure to determine the **best** estimate of Planck's constant $h$.

Slope Method

slope $= \Delta p/\Delta f$

$$= \frac{(19 - 6.0)(10^{-23}\ \text{kg}\bullet\text{m/s})}{(8.8 - 2.8)(10^{19}\ \text{Hz})}$$

slope $= 2.2 \times 10^{-42}$ kg•m

Here the slope is not Planck's constant but must be used to find $h$.

$p = hf/c$

$p/f = h/c$

$h = c(\text{slope})$

$= (3.00 \times 10^{8}\ \text{m/s})(2.16 \times 10^{-42}\ \text{kg}\bullet\text{m})$

$h = 6.5 \times 10^{-34}$ J•s

For the slope calculation, all six guidelines were followed.

Averaging Method: using data points

$h = pc/f$

$h_1 = (2.5 \times 10^{-23}\ \text{kg}\bullet\text{m/s})(3.00 \times 10^{8}\ \text{m/s})/(1.3 \times 10^{19}\ \text{Hz})$

$= 5.8 \times 10^{-34}\ \text{J}\bullet\text{s}$

$h_2 = 6.2 \times 10^{-34}\ \text{J}\bullet\text{s}$

$h_3 = 7.2 \times 10^{-34}\ \text{J}\bullet\text{s}$

$h_4 = 6.3 \times 10^{-34}\ \text{J}\bullet\text{s}$

$h_5 = 6.8 \times 10^{-34}\ \text{J}\bullet\text{s}$

$h_6 = 5.8 \times 10^{-34}\ \text{J}\bullet\text{s}$

$$h_{(\text{ave})} = \frac{h_1 + h_2 + h_3 + h_4 + h_5 + h_6}{6}$$

$= 6.4 \times 10^{-34}\ \text{J}\bullet\text{s}$

In finding the average value for Planck's constant, all six values were calculated. These values were then averaged. This method may yield different results because of the inclusion of points that have large experimental errors. Note that the averaging equation was explicitly stated. However, it is acceptable to state the averaging equation implicitly.

In this particular problem, the following method yields a reasonable value for Planck's constant but is generally considered unacceptable.

$$p_{(\text{ave})} = \frac{\Sigma p}{6} \qquad = 13.8 \times 10^{-23}\ \text{kg}\bullet\text{m/s}$$

$$f_{(\text{ave})} = \frac{\Sigma f}{6} \qquad = 6.45 \times 10^{19}\ \text{Hz}$$

$$h_{(\text{ave})} = \frac{p_{(\text{ave})} \bullet c}{f_{(\text{ave})}} \qquad = 6.4 \times 10^{-34}\ \text{J}\bullet\text{s}$$

This method gives the correct answer **only** because the graph goes through the origin; as a general practice, the origin should **not** be used. Often, when experimental errors are present, graphs that are meant to go through the origin do not go through it. Thus the use of this particular procedure involves making an unwarranted assumption.

## *Directions for the 1993 Field Tests*

- We will continue to field test numerical-response questions. Each one-hour field test will contain 15 multiple-choice questions, five numerical-response questions, and one written-response question.
- We will continue to field test open-ended written-response questions covering experimental design and practical technology. The tests will also include machine-scored and open-ended questions that are contextually based. Students will be asked questions that may relate to their own personal experience outside what they have experienced in the context of the classroom.

# *APPENDIX A* Calculator Policy

## POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

### Background

The knowledge, skills and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technological developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diploma examinations in mathematics, chemistry, and physics does not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

### Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

### Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics, chemistry, and physics. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

### Procedures

1. At the beginning of a course, teachers must advise students of the calculators that may be used when they are writing mathematics, chemistry, and physics diploma examinations.
2. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.
3. During exams, supervising teachers must ensure that
    a. all calculators fall within the definition provided with this policy,
    b. all calculators operate in silent mode,
    c. students do not share calculators,
    d. students do not bring external devices to support calculators into the examination room. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlining operational procedures for scientific calculators.

*APPENDIX B*

# Examination Rules

## GRADE 12 DIPLOMA EXAMINATIONS

1. **Admittance to the Examination Room**
Students must not enter or leave the examination room without the consent of the supervising teacher.

2. **Student Identification**
Students must present identification that includes their signature and photograph. One of the following documents is acceptable: driver's licence, passport, or student identification card. Students must not write an examination under a false identity or knowingly provide false information on an application form.

3. **Identification on Examinations**
Students must not write their names or the name of their school anywhere in or on the examination booklet other than on the back cover.

4. **Time**
Students must write an examination during the specified time and may not hand in a paper until at least one hour of the examination time has elapsed. Students who arrive more than one hour after an examination has started will not be allowed to write the examination. Students who arrive late but within the first hour of an examination sitting may be allowed to write only at the discretion of the supervising teacher.

5. **Discussion**
Students must not discuss the examination with the supervising teacher unless the examination is incomplete or illegible. Students must not talk, whisper, or exchange signs with one another.

6. **Answer Sheets**
Students must use an HB pencil to record their answers on the machine-scorable answer sheets.

7. **Written Responses**
All work for the written-response sections of the diploma examinations must be done in the examination booklet. Students are expected to write their revised work in blue or black ink for English 30, English 33, Français 30, Social Studies 30, and Biology 30.

8. **Material Exchanges**
Students must not copy from other students or exchange material. Notes in any form—including those on papers, in books, or stored in electronic devices—must not be brought into the examination room. Calculator programs designed to perform mathematical computations or those designed to assist students in graphing are not classified as notes.

9. **Materials Allowed**
***English 30, English 33:*** Students may use a dictionary and a thesaurus for Part A only. Electronic devices are not allowed for either part.
***Français 30:*** Students may use a dictionary, a thesaurus, and a book of verb forms for Partie A only. Electronic devices are not allowed for either part.
***Social Studies 30, Biology 30:*** Students may not use electronic devices.
***Mathematics 30:*** Tear-out data pages are provided in the examination booklet. Students may use scientific calculators (see *Calculator Policy, General Information Bulletin*) but must not share them.
***Chemistry 30, Physics 30:*** A separate data booklet is provided for each of these examinations. Students may use scientific calculators (see *Calculator Policy, General Information Bulletin*) but must not share them.

   Students are expected to provide their own writing materials, including pens and HB pencils, calculators, or other necessary instruments. Tear-out pages for rough work are provided in each biology, chemistry, mathematics, and physics examination booklet.

10. **Translation Dictionaries**
Students are not allowed to use translation dictionaries in any subject. Exchange students must satisfy the same requirements as other students.

# *APPENDIX C*

## *EXPLANATION OF COGNITIVE LEVELS*

### KNOWLEDGE

*Knowledge* is defined as those behaviors and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material, or phenomena. This level comprises knowledge of terminology, specific facts (dates, events, persons, etc.), conventions, classifications and categories, methods of inquiry, principles and generalizations, and theories and structures.

### COMPREHENSION AND APPLICATION

*Comprehension* refers to responses that demonstrate an understanding of the literal message contained in a communication. This means that the student is able to translate, interpret, or extrapolate. Translation refers to the ability to put a communication into another language. Interpretation involves reordering ideas (inferences, generalizations, or summaries). Extrapolation is the ability to estimate or predict based on an understanding of trends or tendencies.

*Application* requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

### HIGHER MENTAL ACTIVITIES

*Analysis*, *synthesis*, and *evaluation* are included in this category. Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypotheses, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis or to the argument in support of that thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize a writer's viewpoint.

Synthesis is the production of a unique communication. It is the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

Evaluation is defined as making judgments about the value of ideas, solutions, and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical, or satisfying. Evaluation includes the ability to apply given criteria to judgments of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

# *APPENDIX D*

## *GUIDELINES FOR SIGNIFICANT DIGITS, MANIPULATION OF DATA, AND ROUNDING IN THE MATHEMATICS, CHEMISTRY, AND PHYSICS DIPLOMA EXAMINATIONS*

### SIGNIFICANT DIGITS

1. Regardless of decimal position, for all nonlogarithmic values any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 $2.30 \times 10^3$
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits,
   but a pH of 7 has no significant digits

### MANIPULATION OF DATA

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   $$\begin{array}{rl} 12.3 & \text{(least precise)} \\ 0.12 & \\ \underline{12.34} & \\ 24.76 & \end{array}$$

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   $(1.23)(54.321) = 66.81483$

   The answer should be rounded to 66.8.

3. When a series of calculations are performed, the answer should not be rounded off based upon interim values. For example:

   $(1.23)(4.321)/(3.45 - 3.21) = 22.145125$

   The answer should be rounded to 22.1.

### ROUNDING

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

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